February 11. "The Sun" (with illustrations), by Professor Philip Fox, Northwestern University.

February 25. "Liquid Air" (with demonstrations), by Professor Henry Crew, Northwestern University.

March 10. "Radium" (with demonstrations), by Professor H. N. McCoy, University of Chicago.

March 24. "Modern Views of Electricity" (with demonstrations), by Professor R. A. Millikan.

April 7. "Problem of Food Productions" (with illustrations), by Professor John M. Coulter, University of Chicago.

April 21. "Bacteria of the Alimentary Canal" (with illustrations), by Professor A. I. Kendall, Northwestern University.

WALLACE W. ATWOOD,
Secretary

THE ASTRONOMICAL SOCIETY OF THE PACIFIC

AT the annual meeting of the Astronomical Society of the Pacific, held in San Francisco, Saturday, January 29, 1916, the Bruce Gold medal for 1915 was presented to Dr. George Ellery Hale, director of the Solar Observatory (Carnegie Institution), Mt. Wilson, Pasadena, Calif., for distinguished services to astronomy. This medal was founded by Miss Catherine Bruce, of New York, in 1897 with a fund of $2,500, and in the past eighteen years has been awarded to thirteen astronomers.

The following astronomers who have been the recipients of the medal were:

Simon Newcomb, United States.
Arthur Auwers, Germany.
Sir David Gill, England.
Giovanni V. Schiaparelli, Italy.
William Huggins, England.
Hermann Carl Vogel, Germany.
Edward C. Pickering, United States.
George W. Hill, United States.
Jules Henri Poincaré, France.
J. C. Kapteyn, Holland.
O. Backlund, Russia.
W. W. Campbell, United States.
George E. Hale, United States.

The nominations and the awarding of this medal are probably the most unique in the history of science. Six of the leading observatories in Europe and America, namely, Berlin, Greenwich, Paris, Harvard, Yerkes and Lick Observatories make the nominations. These are sent to the directors of the Astronomical Society of the Pacific, who make the final selection from these nominations for the gold medal.

Professor R. G. Aitken, astronomer, Lick Observatory, in his retiring president's address, paid a tribute to Dr. Hale's work, as a student, director of the Yerkes Observatory and the Solar Observatory, and in the problems of solar physics. The address will be published in full in the publications of the society.

The second address of the evening was given by Dr. H. D. Curtis, Lick Observatory, on the "Recent Theories of Stellar Evolution." This was followed by the election of officers for the ensuing year. *President,* Dr. S. D. Townley, Stanford University; *Vice-president,* C. S. Cushing, San Francisco; *Second Vice-president,* Dr. H. D. Curtis, Lick Observatory; *Third Vice-president,* A. H. Markwart, San Francisco; *Secretary-Treasurer,* D. S. Richardson, San Francisco.

THE BOTANICAL SOCIETY OF AMERICA

THE tenth annual meeting of the Botanical Society of America was held under the auspices of the Ohio State University at Columbus, Ohio, December 27–31, 1915, in affiliation with Section G of the American Association for the Advancement of Science, the American Phytopathological Society and the American Society of Naturalists.

The council for 1916 is as follows:

President—R. A. Harper, Columbia University.

Vice-president—Geo. T. Moore, Missouri Botanical Garden.

Treasurer—Arthur Hollick, Staten Island Association of Arts and Sciences.

Secretary—H. H. Bartlett, University of Michigan.

Councilors—David Fairchild, Bureau of Plant Industry; Wm. F. Ganong, Smith College; B. E. Livingston, The Johns Hopkins University.

One hundred and forty-six new members were elected, and an amendment to the constitution was passed which does away with the grade of "fellow" in the society. The membership of the society is now approximately 500.

The address of Retiring President A. S. Hitchcock, "The Scope and Relations of Taxonomic Botany," followed the *annual dinner for all botanists,* which was attended by 153 members of the affiliating societies. It will be printed in SCIENCE.

The following papers were given by invitation of the council, and will appear in the *American Journal of Botany:*

"The Specificity of Proteins and Starches in relation to Genera, Species and Varieties," by Professor Edw. T. Reichert.

"The Mechanics of Dormancy in Plants," by Professor William Crocker.

"The Periodicity of Freshwater Algæ," by Professor E. N. Transeau.

Joint sessions were held with Section G, American Association for the Advancement of Science and with the American Phytopathological Society, in addition to three general sessions of the society and two sessions of the Physiological Section. The titles and abstracts of the 69 papers follow:

The Bearing of Certain Senile Changes in Plants on Present Theories of Senility: H. M. Benedict.

Present theories of senility are based almost exclusively upon the study of senile degeneration in animal cells and organs.

Now that typical senile degenerations in *Vitis vulpina* and other perennial plants have been shown to occur, senility seems to be more inherently connected with living matter than was formerly supposed to be the case. Theories of senility, if true, must therefore be as applicable to senile degeneration in plants as in animals. The nine more common theories of senility are stated and classified, and examined in the light of the new data obtained from plants. Of these the theory, first advanced by Kassowitz (1899) and supported by Hertwig and Childs, that senility is due to an accumulation of inert catabolic products, is open to the least objection. A suggestion is offered that a more fundamental cause of senility than this may be found in the colloidal constitution of protoplasm with its units in the form of molecular complexes. The tendency, exhibited by certain non-living colloids, of a progressive change toward closer approximation of the molecules constituting the unit, for example, if also occurring in protoplasm would bring about changes in water content, permeability and in other characters which in turn might produce the accumulation of inert or toxic catabolic products.

The Mutual Relations of Host and Parasite in the Genus Gymnosporangium: B. O. Dodge.

It has been previously shown that the leaf form of *Gymnosporangium* on *Chamæcyparis* will infect *Aronia* and *Amelanchier,* giving two different types of æcidia. The galls produced on these hosts are also characteristically different. Later experiments show that different species of *Amelanchier* when infected with the stem form, *Gymnosporangium biseptatum,* develop different types of galls. Variation in the dimensions of the æcidia are also quite marked. This is in line with the results obtained by Long in connection with his experiments with *Puccinia ellisiana* and *P. andropogonis,* and Pammel's observations on the variation in the form of the peridial cells, etc., of *Gymnosporangium macropus* found on different hosts.

What are Chondriosomes? D. M. Mottier.

Argument.—If meristematic tissues of various plants are fixed in a certain mixture of chromosmic acid and sections made therefrom are stained with iron-hematoxylin or crystal violet (Benda's formula), there will be revealed in the majority of cells, in addition to the well-known and familiar cell contents, many small granules, chains of granules or rods of uniform structure but of variable size, that stain blue with crystal violet or black with the iron-hematoxylin. These have been described by various observers as chondriosomes. In the roots of higher plants many of these chondriosomes become leucoplasts, while in the stem they may develop into chloroplasts. Chondriosomes of this nature have been reported from a wide range of families among both higher and lower plants by Guilliermond and others. Different functions have been attributed to these bodies in different plants and in different parts of the same plant. The writer is in harmony with the view that certain so-called chondriosomes become leucoplasts in the root and chloroplasts in the stem. It is argued that in the cells of certain plants examined there are present in addition to these plastids other bodies similar in structure and in reaction to fixing fluids and stains, to the above-mentioned plastids, which do not develop into either leucoplasts or chloroplasts. These bodies are always present in some form (granules or delicate rods) in all cells, reaching a greater development in some cells than in others. They are permanent organs which should be given morphological rank with the nucleus and with the primordia of chloroplasts and leucoplasts. No homology is claimed between the bodies here under consideration and the chondriosomes of animal cells. It is suggested that in function these bodies may be concerned in various ways with the metabolism of the cell, and that, if the cytoplasm is con-

cerned directly with the transmission of hereditary characters, these bodies are to be looked upon as representing hereditary substance. They do not arise from the nucleus. Whether the term chondriosomes should be applied to the organs in question is left an open question.

The Nature of the Cell Plate: C. H. FARR. (Introduced by R. A. HARPER.)

A study of quadripartition of the pollen-mother-cells of a number of dicotyledons, especially *Nicotiana,* in which the cell-division appears to be accomplished without the organization of a cell-plate, but by furrowing as in the division of animal cells. The conditions under which the cells exist were found to approach more closely to those of the typical animal egg than the typical plant cell, namely: the absence of rectilinear cellulose cell-walls; the presence of a mucilaginous matrix, formed by the gelatinization of the walls; the loose disposition in the anther; the spherical form; etc. This suggests a physico-chemical interpretation of the cell-plate, that is, an accumulation of a salt in the equatorial plane between two nuclei. This salt remains in solution if the cell enlarges in response to the osmotic pressure generated by the salt. If, however, the cell can not enlarge either the salt is precipitated or attains such a concentration that the colloids about it are coagulated, thus forming the cell-plate. This conclusion is supported, not only by the present investigation, but by the absence or obscurity of the cell-plate in the algæ and fungi, and by the presence of equatorial structures in many encysted and incrusted animal cells.

The Life-History of Thraustotheca, a Peculiar Water Mold: W. H. WESTON.

In a study of *Thraustotheca clavata* (DeBary) Humphrey, an unusual form hitherto recorded only three times, twice from Germany and once from America, the following facts were ascertained: (1) The process of sporangiospore formation conforms to the usual saprolegniaceous type. (2) The genus is, however, unique among the Saprolegniaceæ in that dehiscence of the sporangium is effected through rupture of the wall as a result of swelling of the non-motile sporangiospores within. The fragility of the sporangium wall, moreover, has been greatly over-emphasized. (3) In their further development the sporangiospores may give rise to zoospores, germ tubes or dwarf sporangia. (4) The zoospores are grooved, laterally bi-ciliate, and of a characteristic shape that can not adequately be described by the terms "reniform" or "bean-shaped" that are generally used in this connection. (5) Gemmæ are formed, but represent merely a transient resting-state induced by unfavorable environmental conditions. (6) In the development of the sexual structures certain phenomena seem to justify the assumption that the formation of antheridia is dependent on contact of the antheridial filaments with the oogonia; and that oospore formation is, under normal circumstances, definitely correlated with the presence of antheridia on the oogonia. (7) In germination the oospores send out hyphæ which either, after limited growth, form sporangia or give rise to extensive mycelia, the type of development depending on the amount of nutriment present. (8) In its structure and development the fungus shows a resemblance to *Achyla* that, in the opinion of the writer, is sufficient to entitle it to a systematic position near the latter genus rather than near *Dictyuchus.*

The Embryogeny of Stangeria: CHARLES J. CHAMBERLAIN.

More than one sperm frequently passes through the neck of the archegonium, but it is extremely rare for more than one to enter the egg. In the metaphase of the first division of the fusion nucleus, only twelve (12) chromosomes, the haploid number, appear; but later divisions show twenty-four (24), the diploid number. Doubtless, the anaphase would show twenty-four (24), as will be described by Hutchinson in a forthcoming paper on *Abies.*

In the earlier free nuclear divisions there is usually a definite polarity, most of the nuclei being in the upper and lower thirds of the proembryo, while the middle third may have no nuclei at all. Toward the close of the free nuclear period all the nuclei in the upper part of the proembryo sometimes divide simultaneously, while those in the lower part remain in the resting condition, so that the nuclei in the upper part become smaller and more numerous than in the lower part. Later, some of the upper nuclei pass to the bottom of the proembryo and, with those already there, divide simultaneously, while those above remain in the resting condition. The embryo is formed from these lower nuclei. During the earlier extra-oval stages, haustorial activity is very prominent.

The Embryo-sac and Embryo of Thismia Americana: NORMA E. PFEIFFER.

Study of this Chicago representative of the Burmanniaceæ shows it to differ from some others of the non-chlorophyllous forms in that the megaspore mother-cell undergoes a reduction division,

giving rise to a row of three cells, the innermost of which functions. A normal eight-celled embryo-sac is found. The pollen has been found to germinate in nature, and probably fertilization occurs, a process not taking place in those forms where there is no reduction. Division of the fertilized egg is preceded by division of the endosperm nucleus. The oldest material available shows an embryo of eight cells, imbedded in conspicuous endosperm cells. The seed shows also the oddly differentiated cells at the chalazal end, as noted by other workers.

The Prothallia of the Cyatheaceæ: ALMA G. STOKEY.

This is a study of fourteen species taken from five of the seven genera of the Cyatheaceæ as given by Engler and Prantl. It includes the supposedly primitive form *Alsophila quadripinnata* C. Chr., also called *Lophosoria pruinata* Pr.

In general appearance the prothallia are of the polypodiaceous type, but in the division Cyatheæ most of the forms have multicellular hairs on both surfaces of the thallus in the anterior region. These hairs are found only on prothallia which have produced archegonia, never on the male prothallia. *Lophosoria* and the five species of the *Dicksoniæ* which were examined do not have multicellular hairs. The antheridia have a basal cell which is usually wedge-shaped; two ring cells, each of which is connected with the outer wall of the antheridium by a lengthwise wall; and two opercular cells, the smaller of which lifts like a valve. The walls, notably those of the stalk and lid cells, are often cutinized. The archegonia are more like those of *Osmunda* than those of *Pteris* and *Adiantum*. They have one or two basal cells; the walls of the neck cells are thickened and are often cutinized; the necks are usually straight. In young archegonia the neck cells have coarsely granular contents, but the neck cells of older archegonia contain a deeply staining mucilage differing somewhat from that produced by the breaking down of the canal cells.

Rapid Methods for Quantitative and Qualitative Studies on the Soil Flora: THOMAS F. MANNS.

The writer since 1901 has spent much time in the study of soil flora. The greatest difficulties encountered have been methods, apparatus and media that would expedite the work. After much experimental work the writer finds the mechanical shaker (run by electric motor) which accommodates sixteen bottles as used for soil analysis, is satisfactory for the preliminary work in properly mixing the sample. With the sixteen containers one may work with the surface samples from sixteen different soils at one time, or he may work with eight samples, including a study of the surface and subsoils. The time required for the plating of 16 soils in duplicate plates with two dilutions on four different media (equivalent to 256 plates) will be from two and one half to three hours. The dilutions will vary according to the groups from 1/1,000 of a gram, to 1/10,000 and 1/100,000 of a gram. The moist sample is prepared very fine and one gram is placed in the eight-ounce bottle (nursing) containing 50 c.c. or 100 c.c. of sterile water. The sample is shaken fifteen minutes. Other dilutions are made from this source.

Usually three media will suffice to bring out the important bacterial groups.

Medium I., for ammonifiers, saprophytic forms including molds, Actinomycetes, etc.

Medium II., for *B. radicicola.*

Medium III., for *Azotobacter, B. radiobacter* and nitrifiers. By means of a constant temperature apparatus, 32 tubes of each of three kinds of media may be kept melted at 43° C. ready for plating. Labelling plates consists in writing soil number, medium number and dilution. For the latter $A = 1/1{,}000$, $B = 1/10{,}000$ and $C = 1/100{,}000$ gram moist soil.

Media for Quantitative and Qualitative Studies on Azotobacter and Nitrifiers (illustrated by cultures): THOMAS F. MANNS.

Several workers, including Winogradsky, Beijerinck, Omelianski, Makrinoff and Löhnis have pointed out the difficulties in culturing nitrogen-fixing and nitrifying bacteria. The same workers and others have shown the importance of certain salts, including the carbonates of magnesium and calcium, also the value of phosphates, certain sugars, soil extracts or humus. Several have shown intimate symbiosis between certain nitrogen-fixing forms such as *B. radiobacter* and *Azotobacter chroococcum.* Löhnis in his "Laboratory Methods in Agricultural Bacteriology," p. 97, has shown the stimulating action of magnesium carbonate and calcium carbonate on the nitrifying bacteria. He states in the same work that "Many different methods have already been tried, but the obtaining of pure cultures of the nitrifying organisms is still a most difficult bacteriological problem. The method which is most to be recommended is the gypsum-magnesium-plating method, proposed by Omelianski and Makrinoff." In reference to *Azo-*

tobacter, he says: "On standard media, it grows only moderately, but, on the contrary, very well on gypsum plates which have been wetted with mannite solution." The writer in making a quantitative survey of the bacteria in various groups of soil organisms, found it necessary to modify and invent new media for the *Azotobacters* and nitrifying organisms; after considerable experimental work it was found that the ingredients of a good *radicicola* or *Azotobacter* medium in a soil extract agar, to which, after tubing was added, about .5 gram of a mixture of insoluble salts, including the carbonates of calcium and magnesium, with kaolin, would bring out the nitrogen-fixing organisms (*Azotobacters, B. radicicola, B. radiobacter*) and the nitrifying organisms (*Nitrosomonas* and *Nitrobacter*). Some of the standard media worked fairly well when balanced by the insoluble minerals. By use of qualitative chemicals the active nitrifying colonies could be easily demonstrated on the plate. These media differ from others in that the insoluble minerals in the tube are shaken up at the time of inoculating and poured into the Petri dish. The studies again emphasize the importance of basic compounds, humus and symbiosis in bringing out *Azotobacter.* The western soils (Colorado, North Dakota) show many *Azotobacter chroococcum.*

Peat Organisms that Slowly Liquefy Agar (illustrated by culture): THOMAS F. MANNS.

While making a study of the flora of raw peat and muck, the writer observed that certain colonies of *bacteria* were able to completely break down the agar and cause deep pitting in the medium. The writer has never met with similar organisms in his extensive culture work on agricultural soils. They are probably quite closely confined to peat and moor soils. Erwin F. Smith mentions in Volume I., "Bacteria in Relation to Plant Disease," p. 32, that "Metcalf has described a bacillus which slowly softens it (agar), and the writer has observed similar phenomena." The organism, which appears to be a micrococcus of about one micron in diameter, was found most abundant in peat that was composted with floats (*ground calcium phosphate*) and *calcium carbonate,* 200 lbs. of each to a ton of the former. The writer has made no extensive morphological, physiological or cultural studies upon the organisms. Note of its occurrence is made here solely from the interest that enzymes of such active properties are produced by bacteria. This agar-digesting organism was grown on the following medium:

	Grams
Mono-potassium-phosphate ($K H_2 PO_4$) ...	4.00
Wood ashes (chestnut)	12.00
Ferric sulphate	.25
Mannite	10.00
Agar	12.00
Water	1,000.00

Some Observations on the Occurrence of Sterile Spikelets in Wheat: A. E. GRANTHAM.

The examination of a large number of varieties of wheat grown at the Delaware Agricultural Experiment Station during 1915 indicates that there is considerable variation in the percentage of sterile spikelets per spike among the leading varieties of winter wheat. The study included observations on wheat sown under ordinary field conditions and by the centgener method. It was noted that the varieties grown under field conditions exhibited a higher percentage of sterile spikelets than where the plants were grown 6 inches apart each way as under the centgener method of planting. That is, the thickness of planting appeared to be a factor directly related to the frequency of sterile spikelets. The number of sterile spikelets per spike (the average of 25 spikes for each variety) and the percentage to the whole number of spikelets were determined for 188 varieties of wheat. Of these varieties 80 were beardless and 108 were bearded. The average percentage of sterile spikelets in the bearded varieties was found to be 25.1 per cent., while the beardless averaged 17.8 per cent. This indicates that the bearded varieties, as a class, have a higher percentage of sterile spikelets than the beardless wheats. Only 20 of the 80 varieties of beardless wheats had more than 15 per cent. of sterile spikelets, while not a single variety of bearded wheat had less than 17 per cent. sterile spikelets. Forty-five of the 108 bearded varieties had 25 per cent., or more, sterile spikelets. Of the 80 beardless varieties only 2 had 25 per cent. sterile spikelets. The occurrence of sterile spikelets was also noted on two varieties of wheat (one bearded and the other beardless), when planted at different dates. The two varieties were planted at seven-day intervals from September 17 to October 22, on fertilized and unfertilized soil. The wheat planted at the earlier dates, whether fertilized or not, had a higher percentage of sterile spikelets than the later seeding. In this case, also, the bearded variety had the higher per cent. of sterile spikelets. Two varieties of wheat fertilized with different combinations and quantities of plant food exhibited considerable variation in the number of sterile spikelets. Phosphoric acid and potash used

singly developed a higher per cent. of sterile spikelets than nitrogen, where two of the plant food elements were used in combination. Nitrogen and potash showed the smallest per cent. of sterile spikelets, while phosphoric acid and potash gave the highest. The untreated plots showed a very low per cent. of sterile spikelets, as compared with those receiving complete fertilizers. Correlation studies between the total number of spikelets per spike and the number of sterile spikelets per spike indicate the longer the spike or the more spikelets it carries, the greater the number of sterile spikelets.

Inbreeding in Maize: DONALD F. JONES.

Twelve generations of continuous inbreeding in maize confirm previous conclusions. The reduction in vegetative vigor is rapid at first, but gradually slows down and finally ceases. This reduction in heterosis is correlated with the theoretical approach to complete homozygosity. There is a marked tendency towards complete uniformity within the limits of physiological fluctuation. Accompanying the reduction in variability there is a segregation of characters and an isolation of subvarieties, some having abnormalities. These subvarieties differ in their power for development as expressed by size of plant and yield of grain. After continued inbreeding there is an approach to the stability of a naturally inbred race. The constantly segregating characters in the original cross-bred race are of little value in classification.

The Chlorophyll-factors in Lychnis dioica: GEORGE HARRISON SHULL.

Three Mendelian factors are responsible for the chlorophyll of the normal dark green biotypes of *Lychnis dioica*. One of these factors, *Z*, differentiates all green strains from albinos, capable only of ephemeral existence. A second factor, *N*, acting with *Z*, produces a form with approximately two thirds as much chlorophyll as the normal. The third factor, *Y*, acts in conjunction with *Z* and *N*, to produce the full green color. In the absence of *N*, *Y* produces no noticeable effect, for plants with the constitution *XXZZnnYY* have not been successfully distinguished from those having the formula *XXZZnnyy*, though plants having these two formulæ have now been separated by cultural methods.

Experiments in Recombining Endosperm Colors in Corn: R. A. HARPER.

My work in crossing corns with different colored endosperms has given me results perhaps best described in general as the so-called "breaking up" of characters as understood by the older plant breeders. Well-established and constant black races crossed with white races have given both in the F_1 and the F_2 generations, series of colors including dark purples, reds, blues, grays, etc., in very many shades. Some of these color types are fairly constant, others fluctuate when selfed. During the past summer a series of recombination tests were made to determine whether the ancestral black could be regained by recombining various pairs of these extracted color forms. The results show a further wide range of variation. The largest per cent. of dark kernels was given by a deep olive-gray pollinated by a dark vinaceous purple, but equally dark individual kernels were given by a pale gray or even by white pollinated by the same red. Deep olive-gray pollinated by dark violet gave quite uniform slate grays and grayish blues with tinges of purple. No immediate and uniform return to the ancestral black is obtained by such recombinations so far as yet tested.

Evidences of Hybridism in the Genus Rubus: C. S. HOAR. (Introduced by E. C. JEFFREY.)

The genus *Rubus* in common with other genera of the Rosaceæ has presented a very difficult problem to the systematic botanist. The species described in certain regions, where the genus has been most carefully studied, mount sometimes into the thousands and are often distinguished with the greatest difficulty on account of intergrading forms. Many systematic botanists have consequently been led to the opinion that in this genus hybridism is extremely common under the conditions found in nature. The present communication is for the purpose of making clear that the morphological data are strongly in favor of widespread hybridism in the genus *Rubus*. It has long been recognized that two prominent and often correlated features of hybridism are extreme variability of species and sterility of the reproductive cells (particularly the pollen). A high degree of imperfection is frequently characteristic of the microspores of *Rubus*, especially in those species which overlap in their geographic range and flowering periods. This condition is well illustrated by the highly variable species *Rubus villosus* and *Rubus strigosus* (the probable parent of the Cuthbert raspberry). On the other hand, in *Rubus odoratus*, a species of a high degree of constancy, which flowers long after the mass of *Rubus* species have cast their blossoms, the pollen presents a high condition of perfection. Similar conditions are presented by the interesting species *R. deliciosus*, limited geographically to the Rocky Moun-

tains. In general there is good evidence from the standpoints of extreme variability and correlated gametic sterility of the widespread occurrence of natural hybridism in the genus *Rubus*. The genus accordingly affords one more argument in favor of the view now rapidly gaining ground, that hybridism is at once a prominent cause of variability and the appearance of new species in the Angiosperms.

Pollen Sterility in Relation to the Geographical Distribution of Some Onagraceæ: CARL C. FORSAITH. (Presented by E. C. JEFFREY.)

The genus *Œnothera* has been mentioned frequently in communications concerning mutation and hybridization. It seems fitting, therefore, that other genera of the Onagraceæ should be examined for evidences of inter-species crossing. The well-established correlation of pollen sterility and hybridization is considered as a determining factor in this connection. Studies of the *Chamaenerion* subgenus of *Epilobium* presents interesting results. Anthers chosen from the more southern representatives of *Epilobium angustifolium* L. show uniformly potent microspores. Selections of material from stations where this plant is coexistent with its ally, *E. latifolium* L., disclose often abundant abortive pollen grains. The more uniformly distributed group belonging to subgenus Lysimachion, reveals impotent microspores quite generally. The monotypic *Zauschneria californica* Presl. and the geographically limited *Epilobium angustifolium* are seen to present unimpaired fertility. *E. angustifolium*, however, occurring within the territorial limits of *E. latifolium* in North America, manifests microscopic proof of previous cross-fertilization. This feature is in marked contrast to the more uniformly perfect pollen development habitually present in the geographically limited species just mentioned. Thus it is apparent, from the morphological standpoint, that interspecies crossing is a not uncommon occurrence among the Onagraceæ where such is not prevented by kinship or distribution. This interesting fact was first noted by Miss Ruth Holden, of Cambridge, England.

Seed Sterility and Delayed Germination in Œnothera: B. M. DAVIS.

A study of fifty species, races and hybrids of *Œnothera*, have given surprising data on the extent of seed sterility and delayed germination within this group. The importance of recognizing in genetical work the problems presented by this situation will be discussed and illustrated. A method will be outlined whereby it is hoped that complete germination of seeds may be rapidly forced to completion and at the same time may permit of the preservation for examination of the residue of sterile seed-like structures.

The Production of 14(+)-Chromosome Mutants by 14-Chromosome Œnothera Lamarckiana: ANNE M. LUTZ.

Gates and Thomas have counted 15 chromosomes in 21 plants variously classified as *Œnothera* mut. *lata*, *O.* mut. *semilata*, *O. lata* to *semilata*, *O.* mut. *lata rubricalyx*, *O. biennis* mut. *lata* and as *lata*-like forms. Gates had mentioned these results in an earlier paper in 1913 referring to *O.* mut. *lata rubricalyx*, which was found among the F_2 offspring of a cross between two 14-chromosome forms, he says: "The possession of fifteen chromosomes by this plant also shows that whenever a meiotic irregularity leads to the formation of an individual having an extra chromosome, such a plant will have the leaves and habit of *lata* or *semilata*." Although he adds in a footnote that "it is possible that one or two other mutants also have an extra chromosome," he does not state that such forms are not *lata*-like; furthermore, Gates and Thomas say later "Certain other mutants indicate by their hereditary behavior that they may also have aberrant chromosome numbers, but this has not yet been proved, except in *gigas*." All of the arguments offered by Gates and Thomas point to the conclusion that whenever a meiotic irregularity in a 14-chromosome form leads to the production of an 8-chromosome gamete, if the latter is capable of functioning, the union of this cell with a 7-chromosome cell will produce *O. lata*, *O. semilata*, or some *lata*-like form. While many 15-chromosome forms have *lata* or *lata*-like characters, many 15-chromosome mutants, offspring of 14-chromosome forms, are quite unlike *O. lata*. I have counted 15 chromosomes in 11 distinct mutant types: (1) *O. lata*, (2) *O. albida*, (3) *O. bipartita*, (4) type 5,509, supposed to be a modified form of de Vries's *oblonga*, (5) *O. nanella lata*, (6) *O. subovata*, (7) type 2,256, (8) type 4,499, (9) *O. exilis*, (10) *O. exundans*, (11) type 5,365. The first six are produced by *O. Lamarckiana* and other forms—the first four being very common types. Type 2,256 is produced by 14-chromosome *O. nanella*, selfed, type 4,499 by *O. lata*, selfed, and by *O. lata* × *O. Lamarckiana*, while the three remaining mutant types have been observed in cultures of selfed *lata* only, thus far. In addition to the foregoing,

15 chromosomes were counted in a form produced by *Lamarckiana*, bearing a number of characters in common with type 5,509. Fifteen (?) chromosomes were counted in *O. elliptica* (*Lamarckiana* mutant)—number not determined precisely—and in an unnamed mutant from one of de Vries's 1912 cultures of *O. lata* × *O. Lamarckiana*, said to combine the characters of *O. lata* with the smooth, shiny leaves of *O. laeta*. Only 2 of the 11 distinct types in which 15 chromosomes were counted precisely by the writer had *lata* or *lata*-like characters; namely, *O. lata* and *O. nanella lata*. Many other named and unnamed mutant offspring of *O. Lamarckiana* and other 14-chromosome types which can not be designated as *lata*-like forms, indicate by the nature of their somatic characters or hereditary behavior, or both, that they have 15 chromosomes; for example, *O. scintillans*, *O. sublinearis*, *O. leptocarpa*, etc.—mutant offspring of *O. Lamarckiana;* and *O. nanella oblonga*, *O. nanella elliptica*, etc., produced by *O. nanella*. While it is possible that 9- and 6-chromosome gametes, capable of functioning, may be produced by 14-chromosome forms occasionally, that a 9- might unite with a 6-, in rare instances, and produce one of the uncommon types of 15-chromosome mutants, it is probable that most 15-chromosome offspring of 14-chromosome forms, particularly the common types—whether *lata*-like or not—result from 8-7 unions. Of particular interest, in connection with this discussion, is the fact that a *lata*-like mutant appeared in a 1908, and another in a 1910, culture of *Lamarckiana* pollinated by *Lamarckiana*. The two did not duplicate each other nor *O. lata*, and each had 16 instead of 15 chromosomes. They may have arisen from 8-8 or 9-7 unions.

A Comparison of the Wood Structure of Œnothera stenomeres and Its Tetraploid Mutation gigas: W. W. Tupper and H. H. Bartlett.

The change from the $2x$ to $4x$ chromosome number in *O. stenomeres* is concomitant with (1) An increase of 50 per cent. in the length of the vessels, and of 150 per cent. in the area of the cross-section. (2) An increase of 50 per cent. in the length and diameter of the tracheids, corresponding to an increase in volume of 200 per cent. (3) An increase in all three dimensions of the ray cells, but not a proportional increase, resulting in a cell of a different shape with an increase of 275 per cent. in volume. (4) A breaking up of the tall multiple medullary rays into their constituent simple rays.

Orthogenetic Saltation in Nephrolepsis: R. C. Benedict.

The title, "Orthogenetic Saltations in *Nephrolepsis*," was selected to emphasize two points: First, the variations to be described are discontinuous and of considerable magnitude, *i. e.*, "jumps" or saltations; second, these variations are definitely directed (orthogenetic) along a few distinctly limited lines. The present consideration is purely descriptive. The variations dealt with are all from one variety, *bostoniensis*, of the species, *N. exaltata*. From this variety have come at least three distinct lines of variation, viz., progressive dwarfing, progressive increase in division of leaf, and progressive increase in waviness of leaf. The illustrations to be given are as follows:

Progressive dwarfing: (1) *bostoniensis—Scotti—Wagneri.* (2) *Roosevelti*—Teddy, Jr.,—new form as yet unnamed.

Progressive increase in division of leaf: (1) *bostoniensis—Piersoni—Barrowsi—Whitmani—magnifica.* (2) *Scotti—Scholzeli* (2-pinnate)—*Scholzeli* (3-pinnate).

Progressive increase in waviness of leaf: (1) *exaltata—bostoniensis—Harrisi*—Wm. K. Harris.

Another type of variation, not progressive but retrogressive, is shown in the reversion forms which, however, can not be mentioned in detail here. Finally, two points are to be emphasized. There are at least sixty different sports of *bostoniensis*, nearly all of which may be placed in one of the series mentioned above. These variations are all vegetatively produced.

An Interesting Modification in Xanthium: Charles A. Shull.

A peculiar modification of the burs of *Xanthium* is described, in which the number of the flowers surrounded by the involucre has been greatly increased. In one specimen, a cross section of the bur showed the presence of twenty-six involucral cavities. Twenty-three of the cavities contained the remains of ovarial walls, twelve of which had normally developed seeds, and eleven of which had aborted. Three cavities showed no indications of ovaries, but their position is evidence of their nature. The manner in which this form originated is unknown, but it seems probable that it is either a mutation or a reversion from *X. canadense*. Unfortunately this interesting variety was extinct, so far as the local appearance is concerned, at the time it was received.

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Secretary

(*To be continued*)